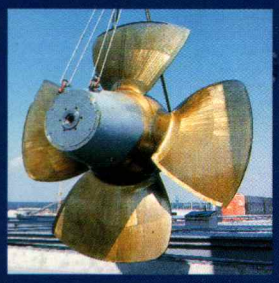
VATECH

**VA TECH HYDRO**

**BULB TURBINES & GENERATORS**

# Water. Power. Large.



Hydro

We know how.

sustainable solutions. for a better life.

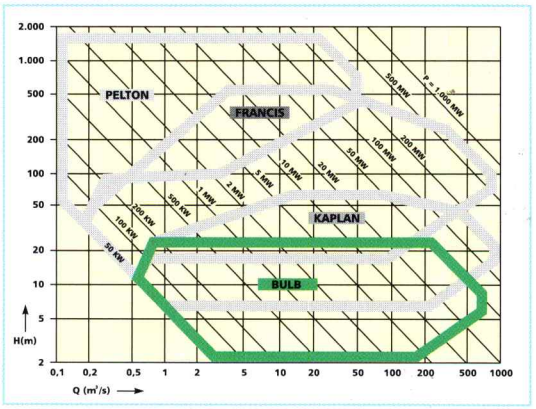
**www.vatech-hydro.com**

VOEST MCE ELIN SAT AUTOMATION

# BULB TURBINES & GENERATORS

## General Concept of Bulb Turbines

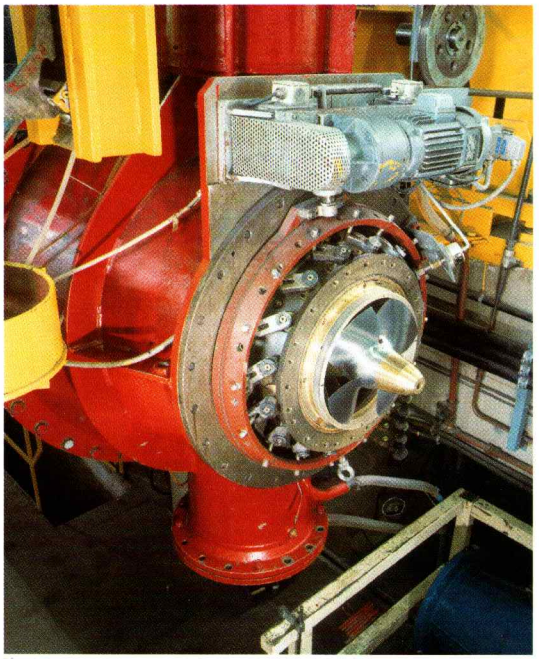
**Today low heads can be used for power generation very economically feasible. More than 300 units supplied by VA TECH HYDRO for heads up to 30 m, a maximum runner diameter of 7,700 mm and outputs up to 55 MW testify the experience in this segment of hydropower generation.**




VA TECH HYDRO is the leader in Bulbturbine / Generator units with a market share of more than 50% in the last decades. The application range includes direct-driven units, pit turbines using a step-up gear to the generator and the so called STRAFLO™ turbines, a special development by VA TECH HYDRO. The total installed capacity worldwide amounts to approximately 4,500 MW.

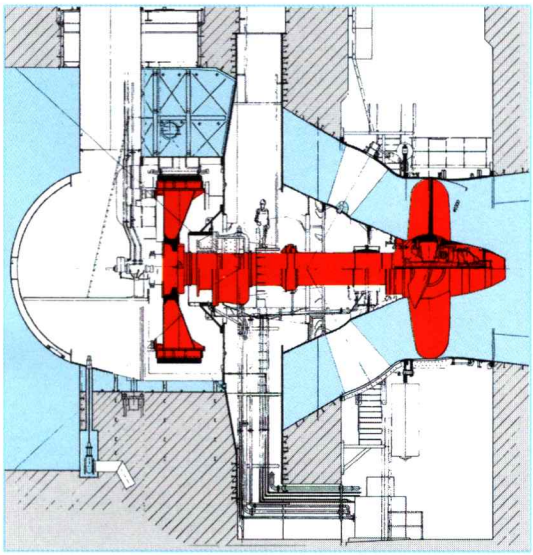
Bulb turbines have the advantage of a straight inflow to the distributor and runner and also the outflow through the conical draft tube has no bend.

This results in a minimum of losses in the entire application range and therefore higher efficiencies.

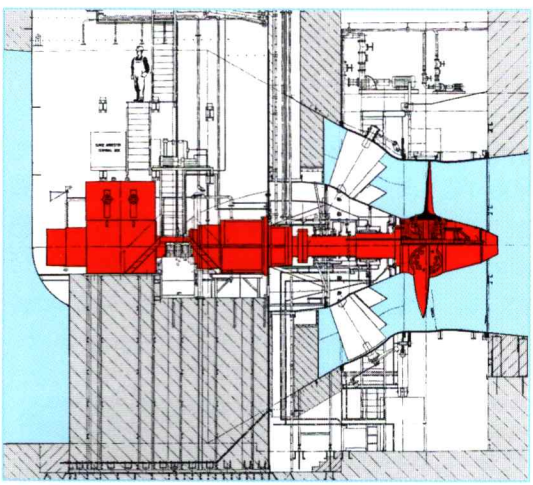


In VA TECH HYDRO's hydraulic test laboratory in Linz, Austria, Bulb turbines are optimized in this respect to ensure highest energy generation for all applications. Bulb turbines can be double or single regulated as far as the wicket gates or the runner blades are concerned.

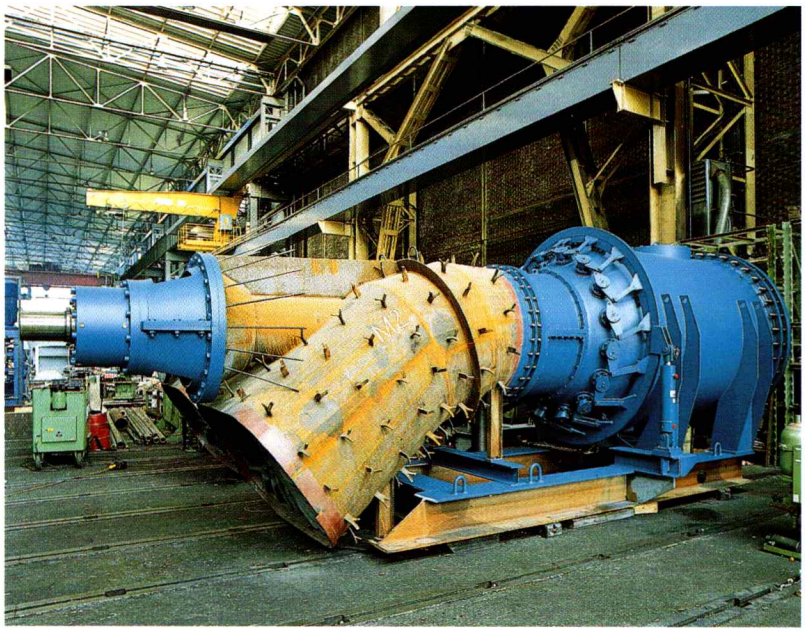
Directly coupled Bulbturbine / Generator units are economically feasible for higher heads of up to 25 m thus offering a sufficent high generator speed. For lower heads pit turbines with step-up gears can be used to allow for high turbine efficiencies at low speeds. High speed generators need less space and are also cheaper. For low heads and small outputs Bulb turbines with bevel gears are used in accordance with our COMPACT HYDRO turbine program. For special applications Bulb turbines with S-shaped draft tubes can be used with the advantage of having the generator outside the waterway.

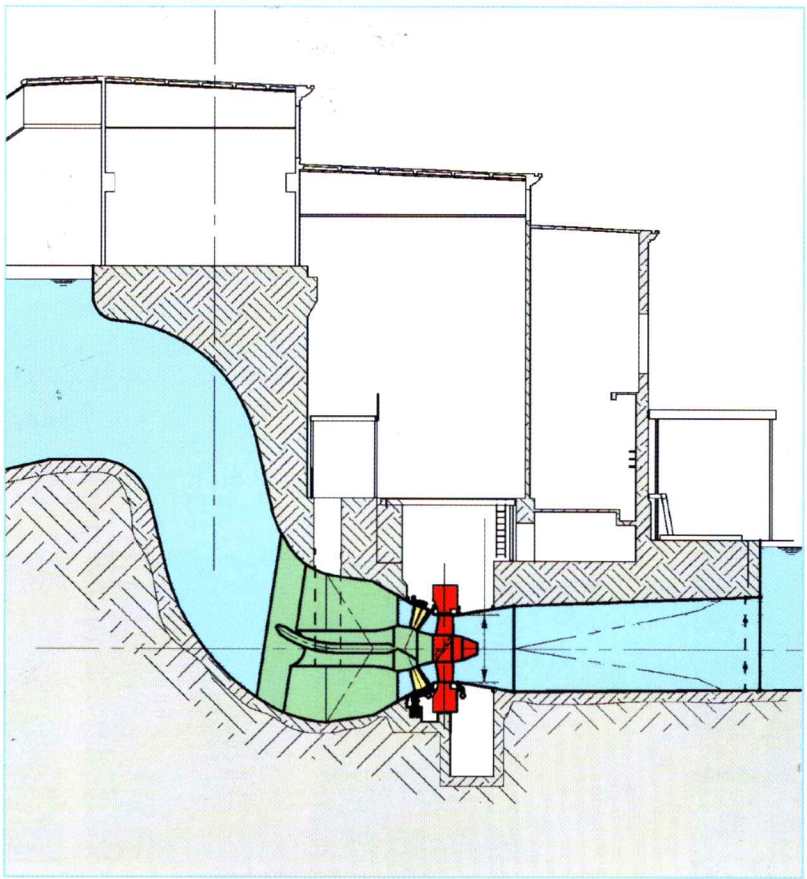


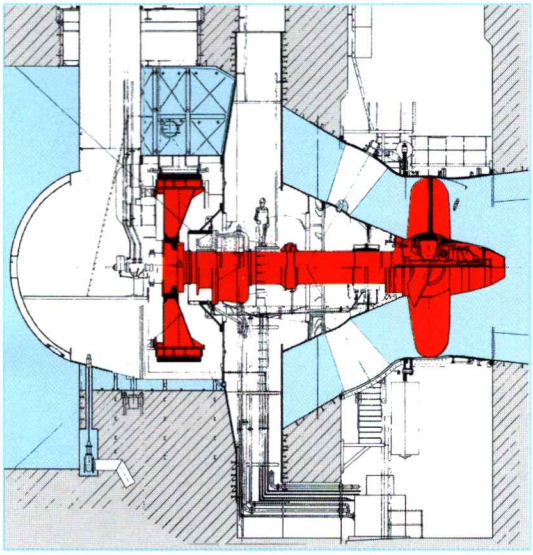
Another special application is the STRAFLO™ turbine. This turbine is a trademarked design having non regulated runner blades and the generator is located outside the turbine runner on a rotor rim.



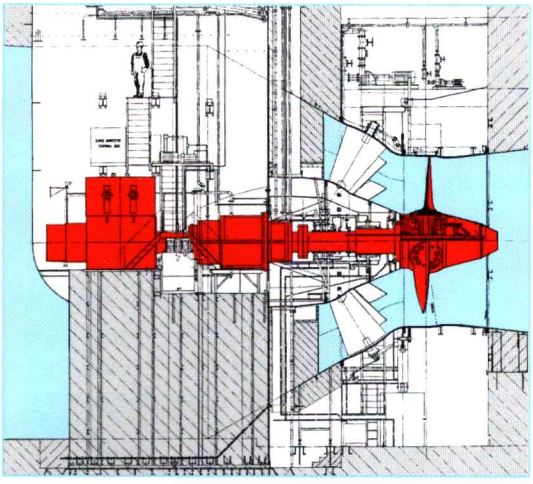
This allows for a very compact and short design, with excellent accessibility and high rotor inertia. STRAFLO™ turbines are in many cases the only feasible solution for upgrading old power stations.



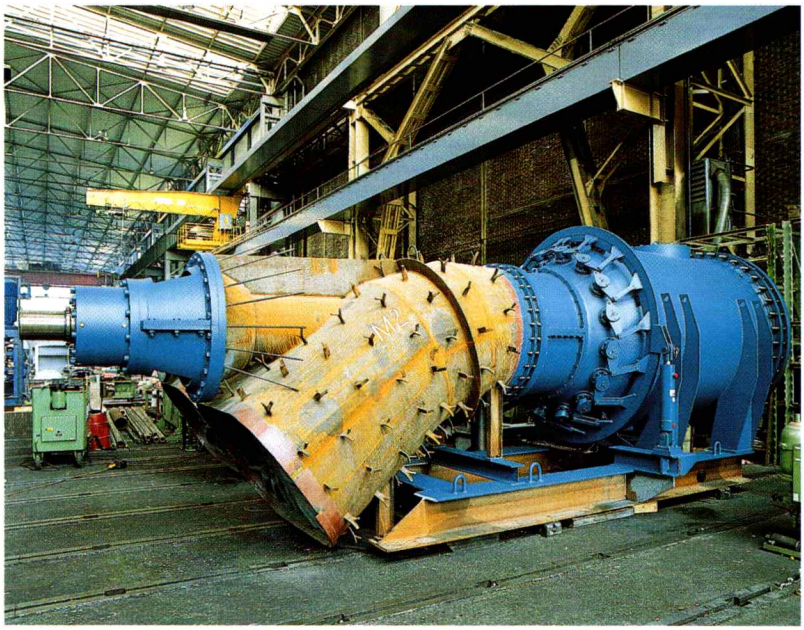


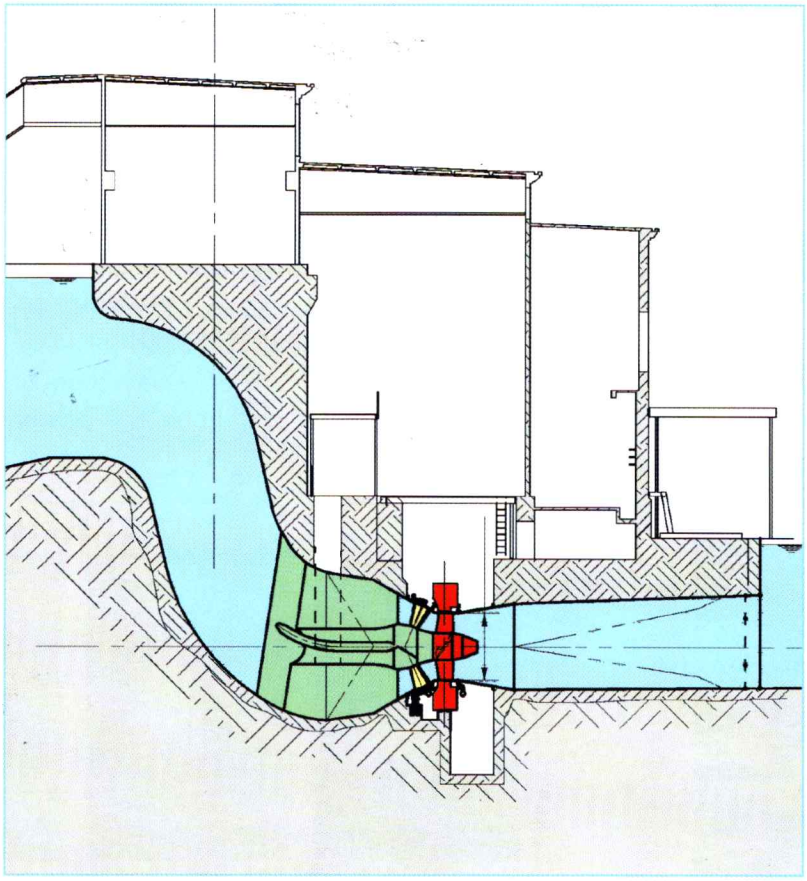


Another special application is the STRAFLO™ turbine. This turbine is a trademarked design having non regulated runner blades and the generator is located outside the turbine runner on a rotor rim.



This allows for a very compact and short design, with excellent accessibility and high rotor inertia. STRAFLO™ turbines are in many cases the only feasible solution for upgrading old power stations.





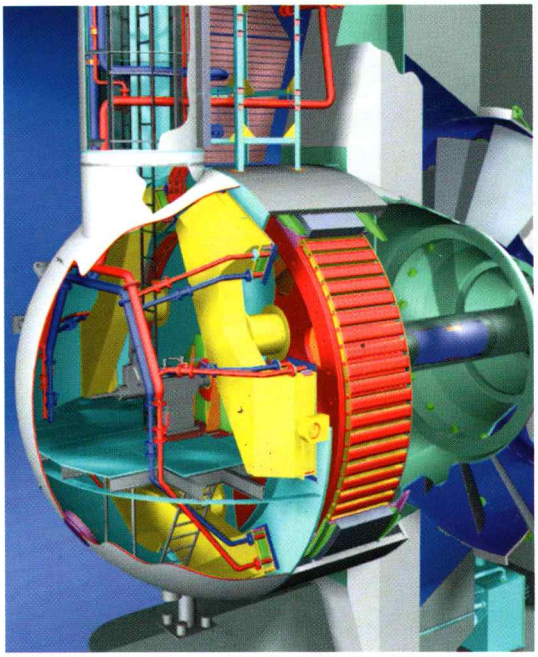
# BULB TURBINES & GENERATORS

## Design Concept of Bulb Generators

**For the generator, the arrangement in an enclosed bulb imposes certain conditions and constraints necessitate an appropriate design. VA TECH HYDRO has more than 30 years of experience with this type of generator and approximately 170 Bulb generators are in operation in 50 power plants all over the world.**

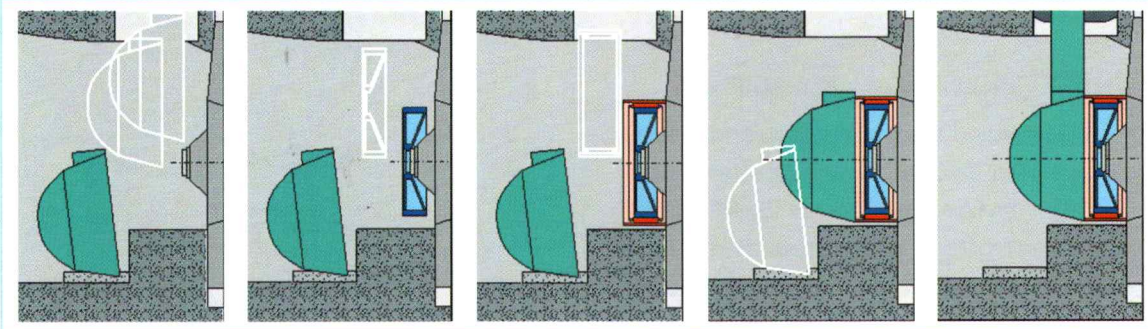
The river water flowing around the unit is an ideal cooling agent for the heat primarily distributed by forced air. VA TECH HYDRO has additionally introduced a cooling system with a closed intermediate cooling water circuit and surface coolers which are either mounted in the water passage or form an integral part of the bulb. Basic advantages of this cooling system include an excellent heat transfer capability, the possibility of integrating bearing and transformer cooling, maintenance free water/water heat exchanger, improved efficiency by staggered operation of water circulating pumps and an elimination of the cooling water system in the power house (pumps, etc.).

Looking at the forces generated by the



Bulb generator, they are transferred to the power house structure via a short and well defined path. Especially for larger units, a rigid vertical column is recommended to connect the inner and the outer cone of the bulb casing and it also serves as an access shaft.

The generator stator, forming part of the bulb, is bolted to the rigid upstream flange of the inner cone of the bulb casing, which also supports the combined generator thrust and guide bearing. This provides additionally significant advantages such



as clear separation of generator and turbine areas, straightforward generator and turbine alignment, adequate access space and a simple installation sequence.

The main erection phase starts after the shaft with turbine and generator bearings has been aligned in its final position. Bulb nose, rotor and stator are lowered one after the other into the water passage and mounted.

In Bulbturbine / Generator power plants, maintenance is much simpler than in vertical Kaplan units. Maintenance tasks on the turbine can be carried out independently of the generator and so no large-scale dismantling of the generator is required.
The main generator parts can easily be accessed for inspections and the removal of stator bars and field poles is possible without dismantling of major components.

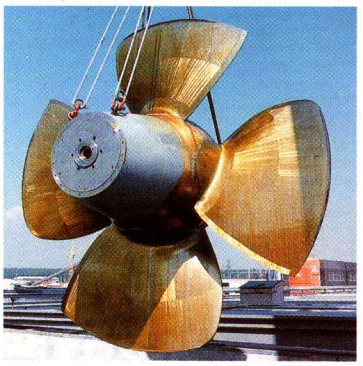
Contrary to earlier trends towards small bulb diameters, nowadays larger diameters of up to 1.3 times the turbine runner are used offering the following advantages:

- High inertia constant
- High generator efficiency
- Simple and effective cooling system
- Reduced mechanical stress and increased bulb nose space.

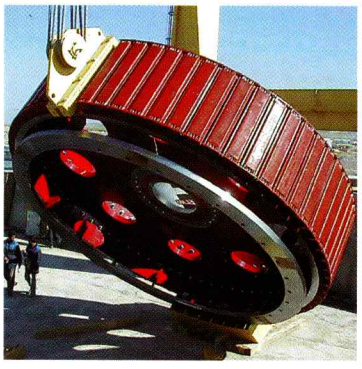
Recently a new and highly competitive concept of a directly driven generator has been developed by VA TECH HYDRO especially for low heads and ratings up to 15 MVA. This BULB 2000 concept with its superb efficiency includes only one common access shaft and is very economical.

## Highlights

1936 First Kaplan Bulb turbine with inside generator at Rostin, Poland
1937 First four Straflo units for Iller VII, Germany
1940 Development of the cascade with more than 60 Straflo units on the river Lech, Germany
1954 First Bulb turbine with a runner diameter of 1,800 mm and an output of 14.4 MW at Argentat, France
1958 Large Bulb turbine with a runner diameter of 4,600 mm at Trier, Germany



1963 Four Bulb turbines with a runner diameter of 5,600 mm and an output of 23.5 MW at Gerstheim, France
1969 First large Bulbturbine / Generator units on the river Danube at Ottensheim, Austria
1973 Largest Bulbturbine / Generator with a runner diameter of 6,000 mm and an output of 40.7 MW at Altenwörth, Austria

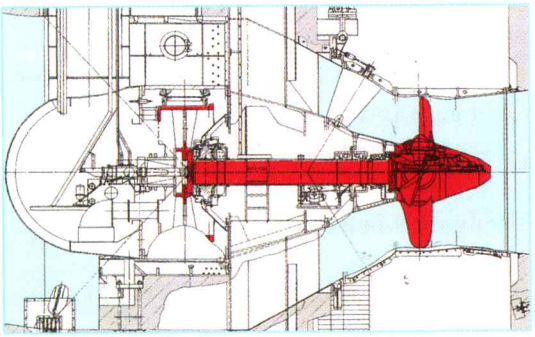


1977 Largest Bulbturbine / Generator units in the world with a runner diameter of 7,700 mm at Racine, USA
1990 Highest output of 15.4 MW for gear driven pit turbine at Swan Falls, USA
1993 Largest output for a Bulbturbine / Generator unit in Europe with a maximum of 55 MW, unit No.7 of Ybbs Persenbeug, Austria
1996 Four Bulbturbine / Generator units with largest stator diameter of 9,000 mm at Da Yuan Du, China
2000 Commissioning of six large Bulb generators with an output of 34.8 MVA at Karkamis, Turkey

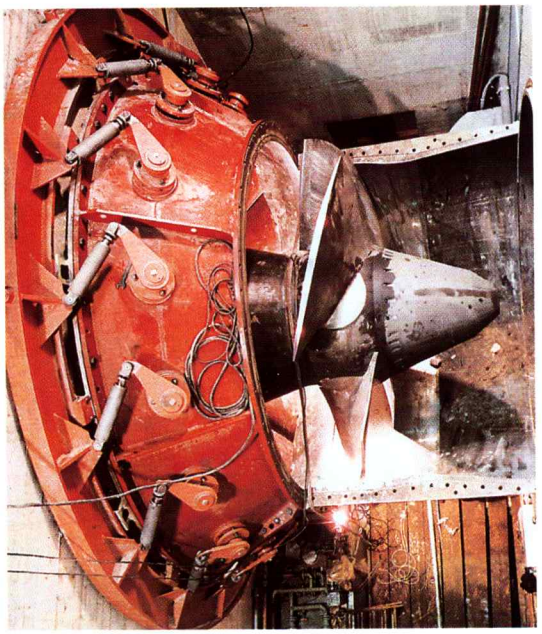
# BULB TURBINE & GENERATOR EXPERIENCE

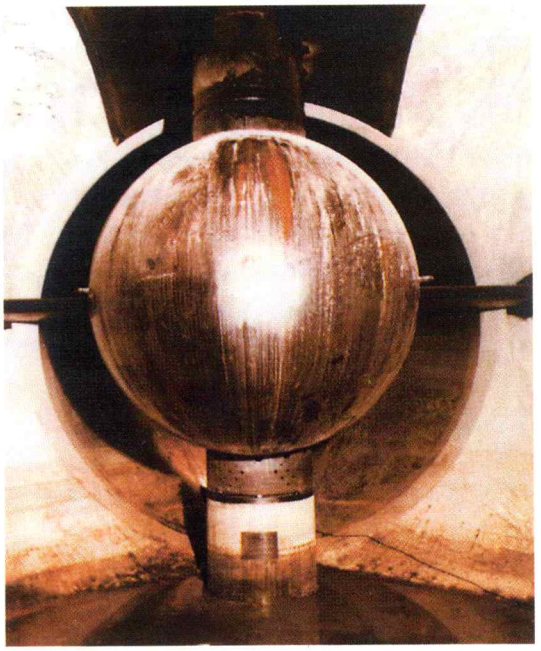
## Kleinmünchen Austria

**This power station is located on a bypass canal of the Traun River near Linz in Upper Austria. It is a good example for the concept of a low head power station in an urban area fitting excellent and environmentally friendly into the landscape.**



Offering high efficiency and optimized annual energy generation, this power plant supplies electricity to many households in this area. The scope of supply of VA TECH HYDRO included model testing, design, manufacturing and installation of two Bulb turbines with electronic-hydraulic speed governors and directly coupled generators including excitation. After a short implementation time this power plant was connected to the grid in December 1977.

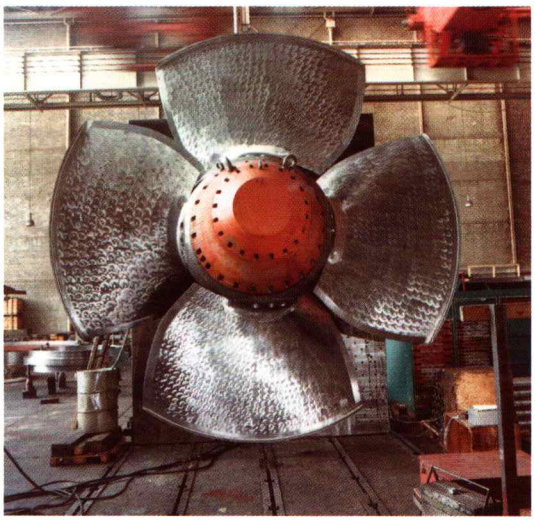




| Technical data: | | |
|---|---|---|
| Output: | 6.2 MW / 6.6 | MVA |
| Voltage: | 3.5 | kV |
| Head: | 10.5 | m |
| Speed: | 166.7 | rpm |
| Runner diameter: | 3,150 | mm |
| Stator diameter: | 3,600 | mm |

## Abwinden-Asten Austria

**This power plant is located downstream of Linz in Upper Austria on the river Danube. It was the third large Bulb turbine power station on the river and was built between 1976 and 1979.**



The power plant includes nine Bulbturbine/ Generator sets and was built in the dry. After completion of construction the river was diverted through the power station. VA TECH HYDRO supplied six turbines and nine generators including excitation and voltage regulation, protection equipment,

step-up transformers, auxiliary systems, controls, measuring and monitoring systems and cabling. Design and manufacturing as well as installation were completed according to schedule and commissioning was successfully performed in 1979.

| Technical data: | | |
|---|---|---|
| Output: | 19.4 MW / 20 | MVA |
| Voltage: | 8 | kV |
| Head: | 8.15 | m |
| Speed: | 93.75 | rpm |
| Runner diameter: | 5,700 | mm |
| Stator diameter: | 6,450 | mm |

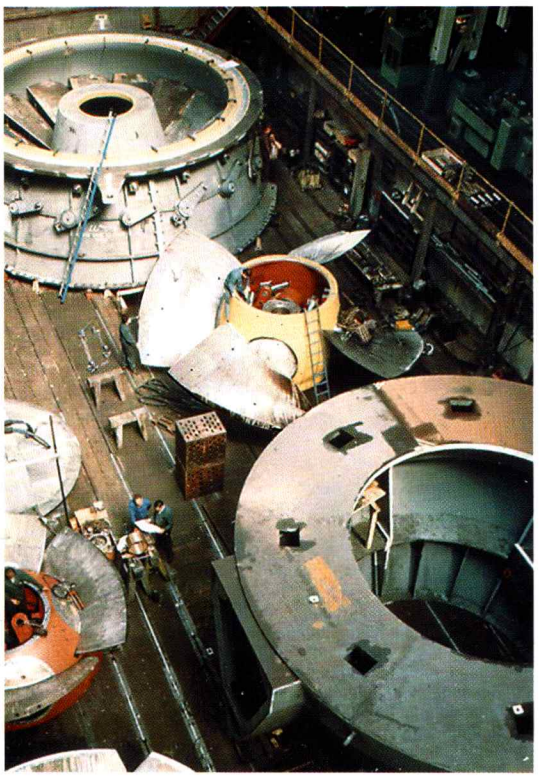
# BULB TURBINE & GENERATOR EXPERIENCE

## Racine
## USA

**The Racine power plant is located on the Ohio River, 384 km south of Pittsburgh about 2.5 km downstream of Letart Falls.**

The project includes a large spillway with eight taintor gates and a ship lock with two chambers. It was originally built for flood control and navigation purposes on the Ohio River and operated by the US Army Corps of Engineers as part of

river cascade. Later it was decided to include a powerhouse for electricity generation operating as a base load scheme and a typical run-off river power station. VA TECH HYDRO was selected to supply two Bulbturbine / Generator units including speed governors and excitation systems. With a runner diameter of 7,700 mm these turbines still hold the world record for directly coupled Bulbturbine / Generator units. Commissioning and start of commercial operation took place in January 1983.

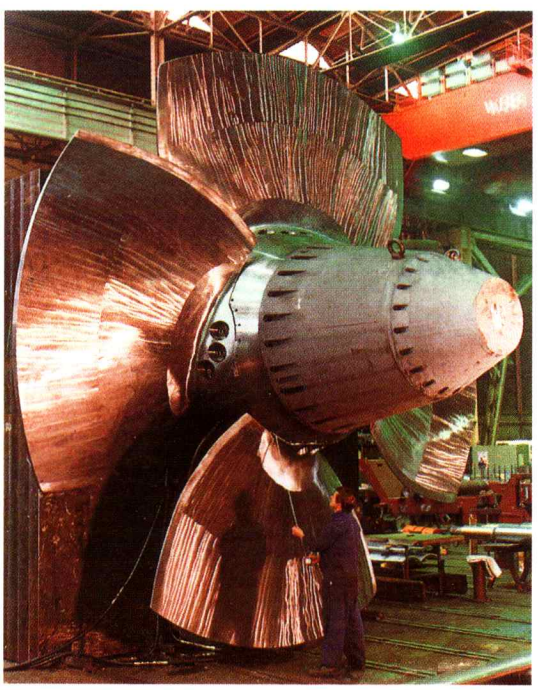


| Technical data: | | |
|---|---|---|
| Output: | 24.6 MW / 25 | MVA |
| Voltage: | 6.9 | kV |
| Head: | 7.0 | m |
| Speed: | 62.1 | rpm |
| Runner diameter: | 7,700 | mm |
| Stator diameter: | 8,640 | mm |

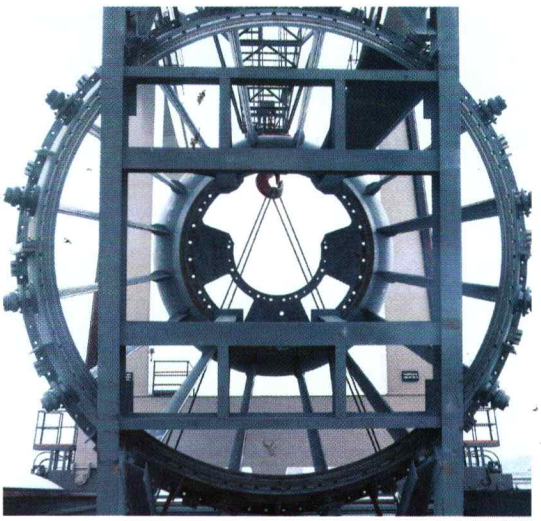
# Melk
# Austria

**The Melk power station was built as a multipurpose project taking into account all economic and ecological factors.**

With the famous monastery of Melk, Lower Austria, in the background, the power station blends into the landscape in an environmentally friendly way. The back-water area extends over a length of 22.5 km from the barrage to the Ybbs-Persenbeug



power station. For reasons of countryside conservation the generated electricity is fed into to the high voltage grid via an underground cable. The powerhouse on the right bank of the river includes nine horizontal shaft Bulbturbine / Generator sets including main transformers, excitation, control and protection systems and cabling.



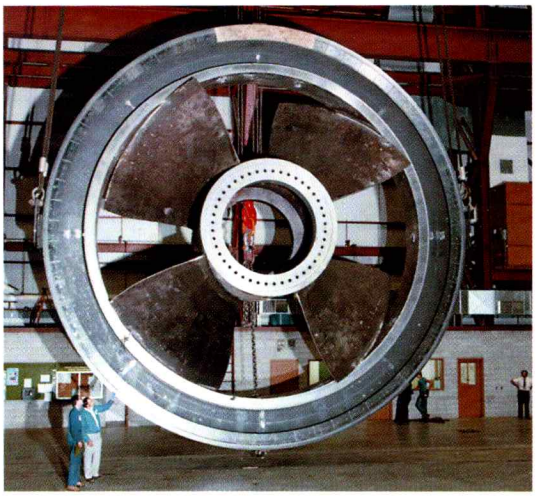
| Technical data: | | |
|---|---|---|
| Output: | 21.7 MW / 24 | MVA |
| Voltage: | 9 | kV |
| Head: | 8.2 | m |
| Speed: | 85.7 | rpm |
| Runner diameter: | 6,300 | mm |
| Stator diameter: | 7,100 | mm |

# BULB TURBINE & GENERATOR EXPERIENCE

## Annapolis Canada

**The Annapolis Royal Tidal plant featuring a STRAFLO™ unit is installed at the Annapolis basin in the Bay of Fundy in the province of Nova Scotia, Canada.**
The STRAFLO™ unit was installed to harness the energy from the tides to a maximum head of 15.8 m. This unit comprises a combined turbine-generator aggregate without driving shaft, because the generator rotor is located outside the turbine runner on a rim. This concept results in a very compact design of the unit.
The runner itself is not regulated using the constant flow of the tides of the seawater.

The turbine is protected against seawater corrosion by a cathodic system.
The Annapolis Royal unit is unique in the world as far as output and dimensions are concerned.
Another STRAFLO™ unit with outstanding performance data was installed in Canada in the late 1990's at the Pointe du Bois Generating Station in the province of Manitoba.



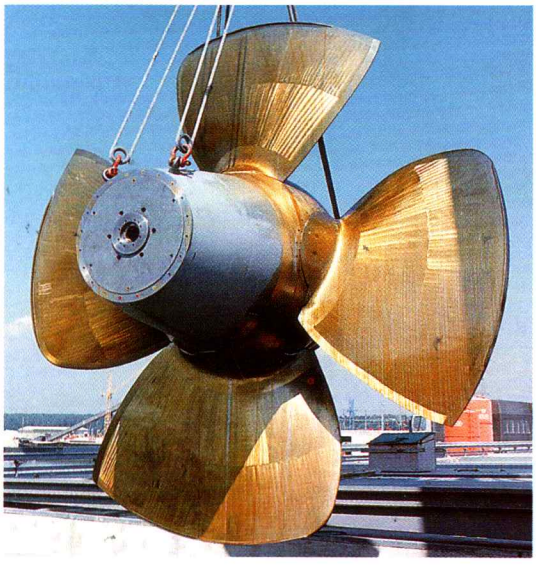
Since 1938, VA TECH HYDRO has produced and put into commercial operation worldwide more than 110 STRAFLO™ units.

| Technical data: | | |
|---|---|---|
| Output: | 19.9 | MW |
| Head: | 7.1 | m |
| Speed: | 50 | rpm |
| Runner diameter: | 7,600 | mm |

## Greifenstein Austria

**The Greifenstein Power Station near Tulln, Austria, was also built in the dry on a left hand bend of the river Danube. It was completed within 30 months which is the shortest construction time ever for a run-off river power station of that size. Furthermore, special emphasis was placed on the protection of the environment during and after construction of the plant.**

The power station consists of nine Bulb-turbine / Generator units and has a weir system of six radial spillway gates and a double ship lock. The VA TECH HYDRO Bulb turbines are optimized to deliver maximum annual energy and the generators are also of a highly advanced design. The stator core clamping devices, the end windings and connection, as well as the field and damper winding connections are conveniently accessible



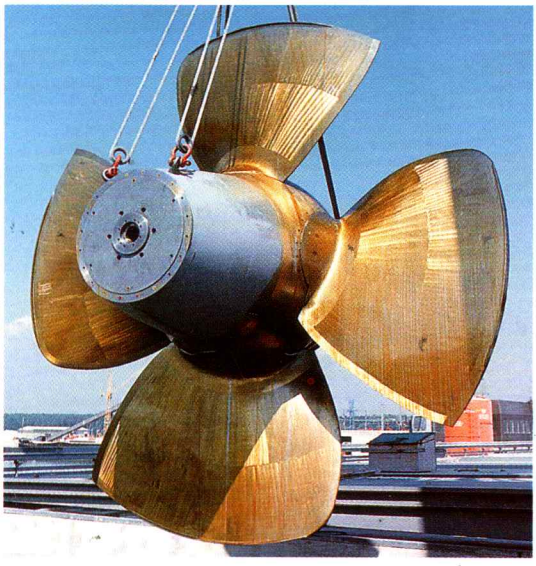
and it is possible to remove field poles and stator bars without disassembly of major components. The VA TECH HYDRO scope of supply included six Bulb turbines and nine three phase generators, 10.4 kV switchgear, excitation, protection and control systems and six radial spillway gates.

| Technical data: | | |
|---|---|---|
| Output: | 35 MW / 38 | MVA |
| Voltage: | 8 | kV |
| Head: | 10.87 | m |
| Speed: | 93.75 | rpm |
| Runner diameter: | 6,500 | mm |
| Stator diameter: | 8,750 | mm |

## Greifenstein Austria

**The Greifenstein Power Station near Tulln, Austria, was also built in the dry on a left hand bend of the river Danube. It was completed within 30 months which is the shortest construction time ever for a run-off river power station of that size. Furthermore, special emphasis was placed on the protection of the environment during and after construction of the plant.**

The power station consists of nine Bulb-turbine / Generator units and has a weir system of six radial spillway gates and a double ship lock. The VA TECH HYDRO Bulb turbines are optimized to deliver maximum annual energy and the generators are also of a highly advanced design. The stator core clamping devices, the end windings and connection, as well as the field and damper winding connections are conveniently accessible



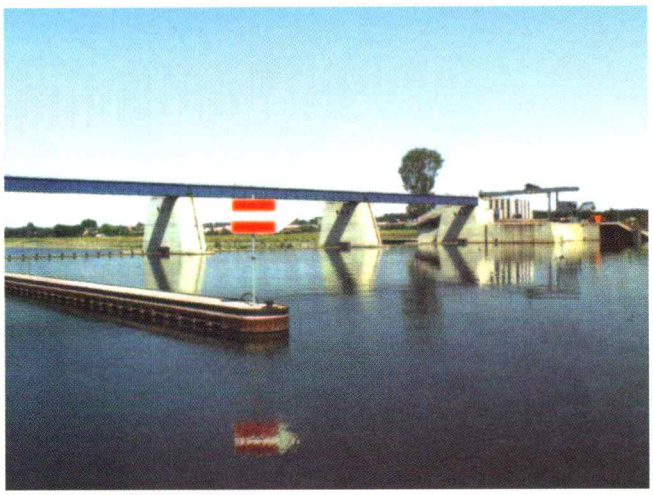
and it is possible to remove field poles and stator bars without disassembly of major components. The VA TECH HYDRO scope of supply included six Bulb turbines and nine three phase generators, 10.4 kV switchgear, excitation, protection and control systems and six radial spillway gates.

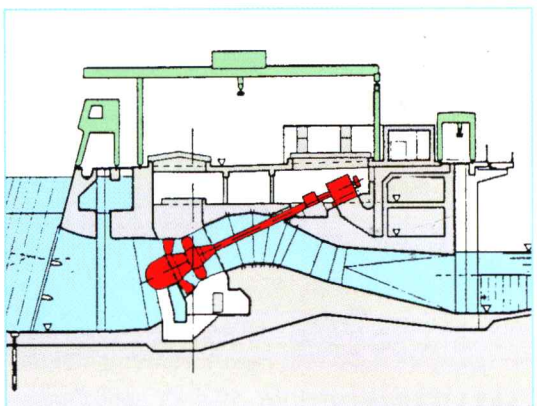
| Technical data: | | |
|---|---|---|
| Output: | 35 MW / 38 | MVA |
| Voltage: | 8 | kV |
| Head: | 10.87 | m |
| Speed: | 93.75 | rpm |
| Runner diameter: | 6,500 | mm |
| Stator diameter: | 8,750 | mm |

# BULB TURBINE & GENERATOR EXPERIENCE

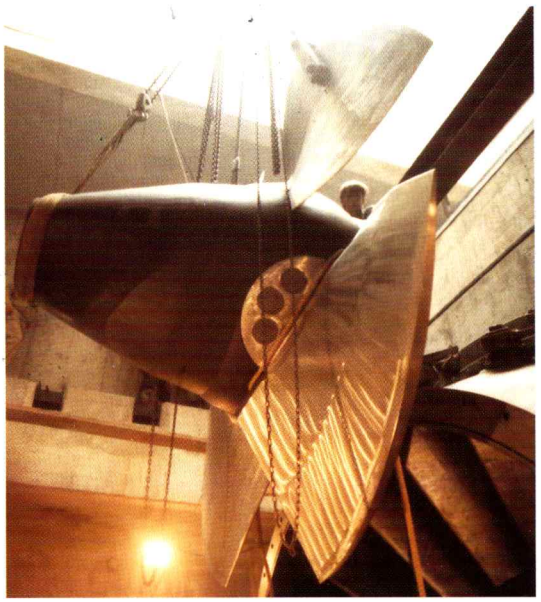
## Offenbach/Kesselstadt Germany

**Located on the river Rhine near Hanau, Germany, these two power stations are designed for base load generation and are typical run-off river power plants.**





The units are designed for maximum energy generation with double regulation and step-up gears enable high speed and very compact designed generators.
The use of an S-shaped draft tube allows for a very flat design of the powerhouse so that it blends well into the environment. The hydropower stations went into commercial operation in 1985 and 1986, respectively.



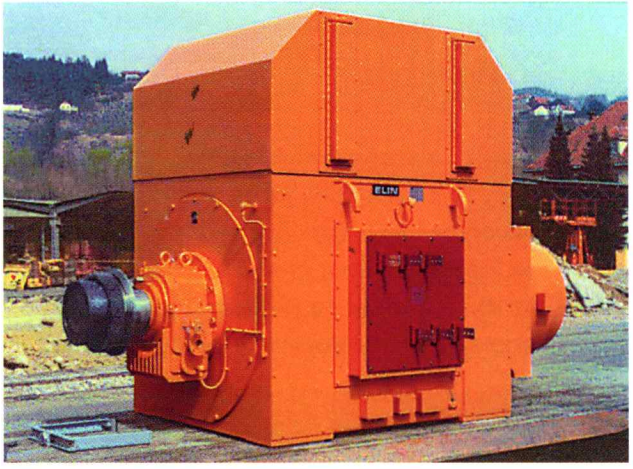
The scope of supply of VA TECH HYDRO included four sets of double-regulated S-type turbines, epicyclic gears, high speed synchronous generators and governor systems with electronic governor heads including oil supply system.

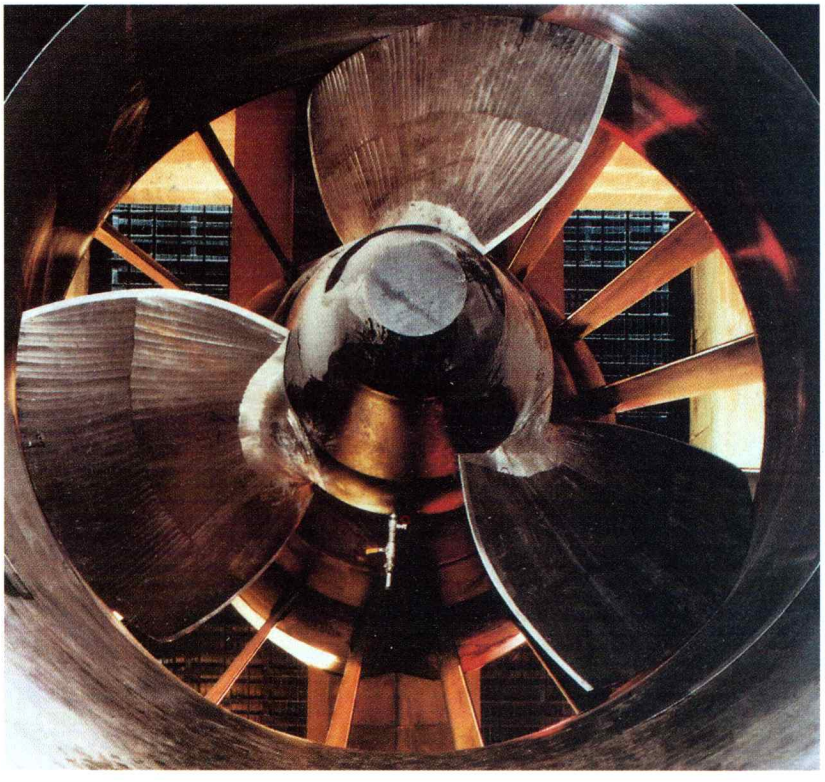
| Technical data: Offenbach/Kesselstadt | | |
|---|---|---|
| Output: | 2.1 / 2.4 | MW |
| Head: | 3 / 3.5 | m |
| Turbine speed: | 73.7 | rpm |
| Generator speed: | 750 | rpm |
| Runner diameter: | 4,450 | mm |

## Arkansas 9 & 13
## USA

**Located at the Lock & Dam 9 and 13 these two power stations are a major development on the river Arkansas in the USA. The projects are of the multi-purpose type including electricity generation, navigation and flood control.**

Including stations No. 8 and 9 on the river Allegheny, equipped with two pit turbine generating units, VA TECH HYDRO has supplied altogether ten large units of that type. The concept includes three-bladed pit turbines for very low heads featuring a planetary step-up gear as speed increaser for a small and cost saving high speed generator.
Electronic-hydraulic speed governors as well as hydraulically operated draft tube emergency gates were part of VA TECH HYDRO's scope of supply.





| Technical data: | Arkansas 9 / 13 | |
|---|---|---|
| Output: | 11.2 / 10 | MW |
| Output: | 11.83 / 10.57 | MVA |
| Voltage: | 4.16 | kV |
| Head: | 4.9 / 4.8 | m |
| Speed: | 77 / 900 | rpm |
| Runner diameter: | 5,800 | mm |
| Stator diameter: | 1,140 | mm |

# BULB TURBINE & GENERATOR EXPERIENCE

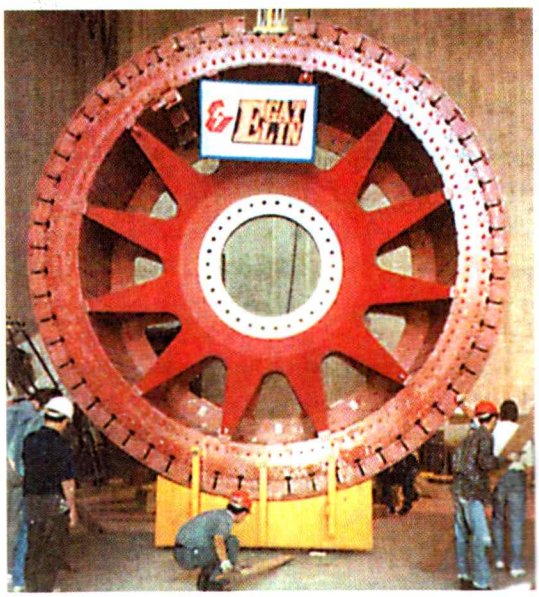
## Pak Mun
## Thailand

**The completion of the PAK MUN hydro-electric project, located on the Mun River in the Ubon Ratchathani province, in the north-east of the Kingdom of Thailand, represents a further milestone in the economic development of the country.**

This remarkable achievement also set a precedent in international circles by introducing the first Bulbturbine / Generator units for a run-off river power station ever installed in South East Asia.

The scope of supply includes four Bulb turbines, generators, governors of digital type, protection, excitation and computerized control, monitoring and supervision equipment, stoplogs and lifting beams, intake trashracks.

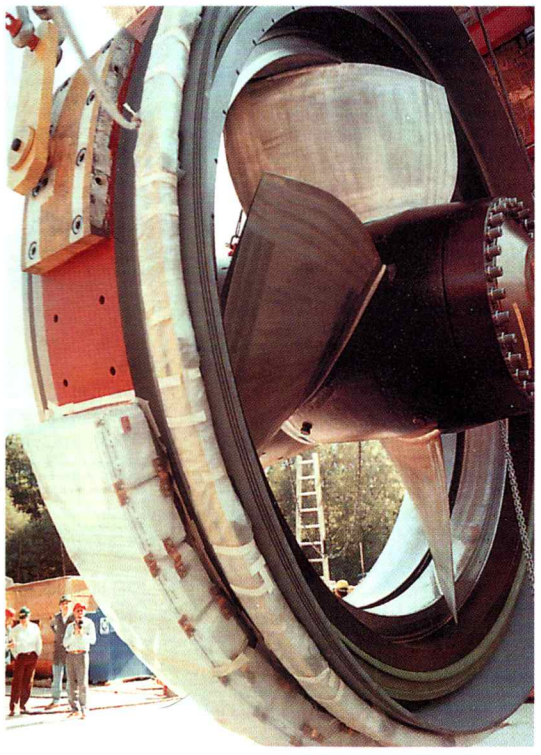
The four units were installed and commissioned in 1993/1994.



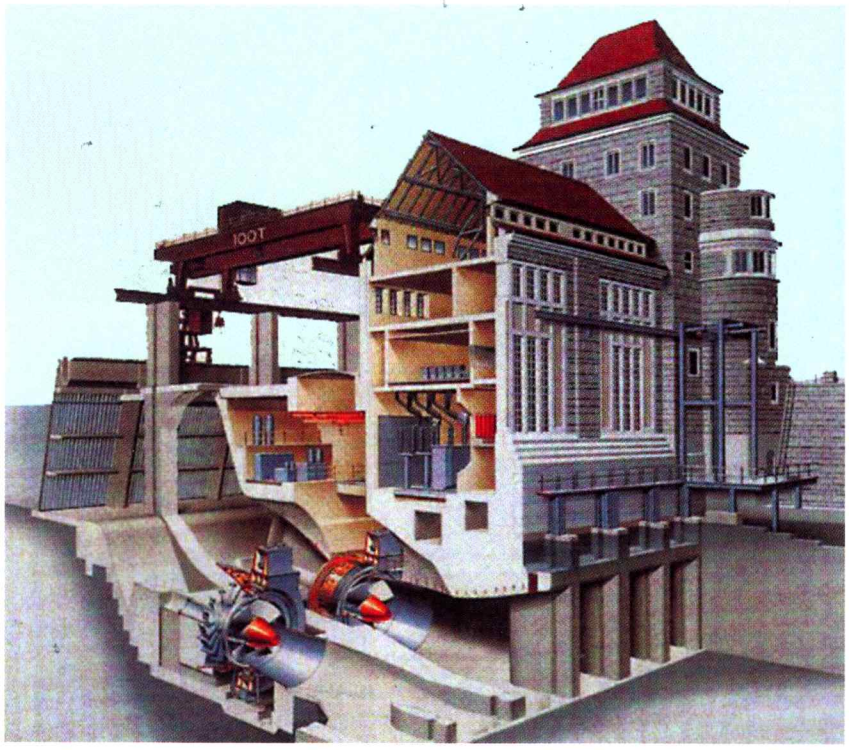
| Technical data: | | |
|---|---|---|
| Output: | 35.4 MW / 35.8 | MVA |
| Voltage: | 6 | kV |
| Head: | 13.5 | m |
| Speed: | 100 | rpm |
| Runner diameter: | 6,000 | mm |
| Stator diameter: | 6,750 | mm |

## Laufenburg Switzerland

**Built between 1910 and 1914 with ten horizontal Francis units equipped with four runners per shaft to generate 48 MW from the headwaters of the Rhine River, the Laufenburg power station was completely modernized from 1988 to 1992.**



The upgrading scheme comprised the replacement of all existing units by ten STRAFLO™ turbine-generator units to increase the plant´s output to 108 MW. Employing new STRAFLO™ units to replace old horizontal or vertical Francis turbines is a tremendously successful concept to overcome space limitations and to meet requirements with respect to minimizing power plant alterations and investment



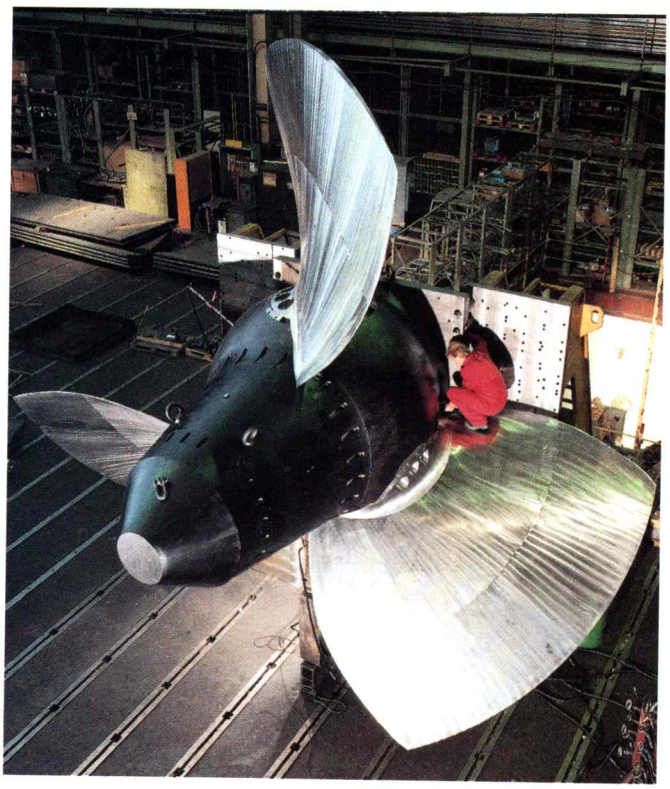

costs. Consequently, this concept has been repeated for several power plant modernizations such as Augst in Switzerland and Wylen in Germany.

| Technical data: | | |
|---|---|---|
| Output: | 11.6 | MW |
| Head: | 10.0 | m |
| Speed: | 107.1 | rpm |
| Runner diameter: | 4,250 | mm |

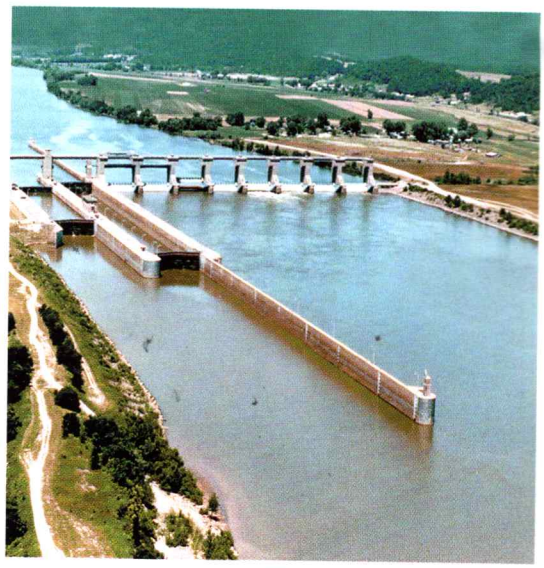
# BULB TURBINE & GENERATOR EXPERIENCE

## Belleville USA

**The Belleville power station is located on the east bank of the Ohio river near Parkersburg, West Virginia, approximately 200 km south-west of Pittsburgh. The plant is a multipurpose installation producing up to 52 MW for its 42 participating municipalities (AMP Ohio).**



With a runner diameter of 7,500 mm these two Bulb turbines supplied by VA TECH HYDRO are among the largest in the world. The supply contract was decided by international competitive bidding after careful evaluation of the total price for equipment, energy generation and experience in the field of low head hydropower installations.

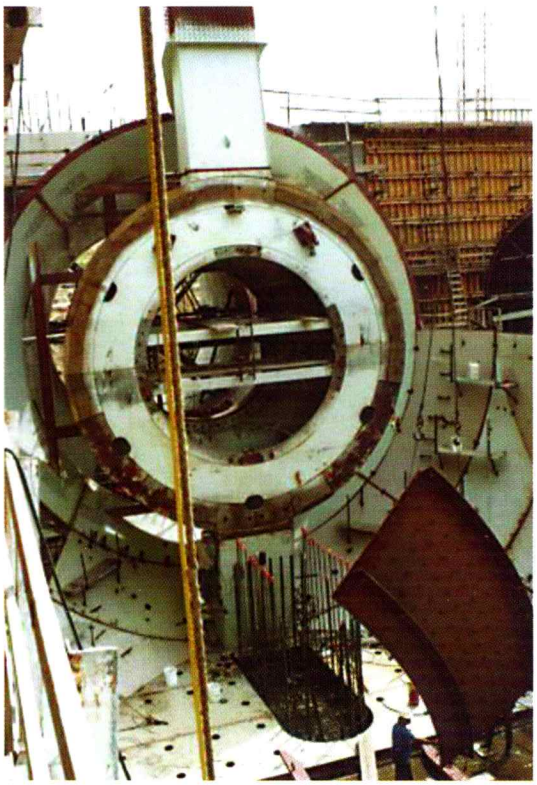


The scope of supply included two three-bladed Bulb turbines with electronic-hydraulic speed governors of digital type, directly coupled three-phase generators, static excitation, supervision of installation and commissioning.

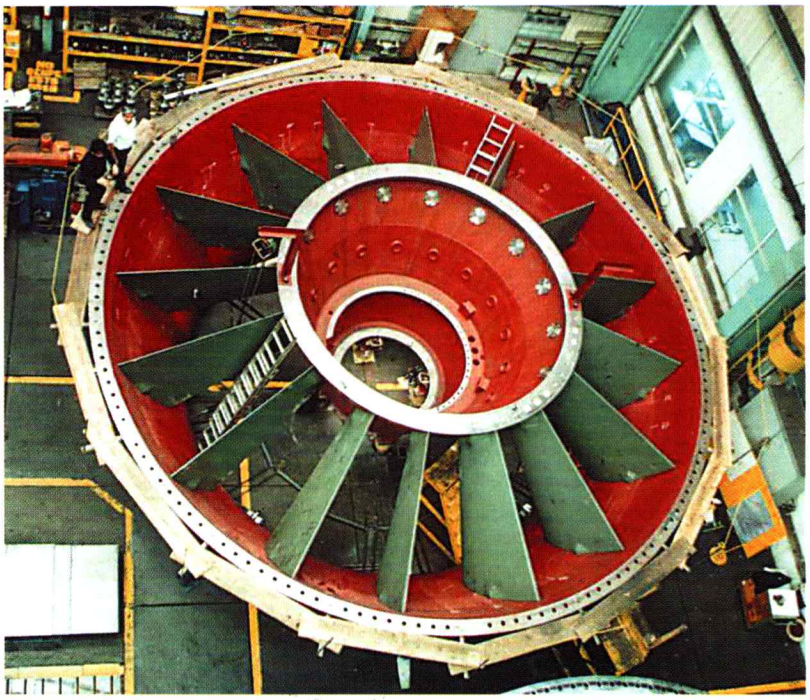
| Technical data: | | |
|---|---|---|
| Output: | 25.9 MW / 27.9 | MVA |
| Voltage: | 6.9 | kV |
| Head: | 5.5 | m |
| Speed: | 64.3 | rpm |
| Runner diameter: | 7,500 | mm |
| Stator diameter: | 7,450 | mm |

## Arkansas 2
## USA

**The project site is located at the U.S. Army Corps of Engineer's Lock and Dam No. 2, the last on the Arkansas river just 20 miles before the junction with the Mississippi river.**



The power station with three large Bulb turbines was successfully commissioned in 1999 and is the largest water power facility owned and established by Arkansas Electric Cooperatives Corporation (AECC).
The turbines are capable of operating over a wide flow and head range and are equipped with a self-regulating cathodic protection system to protect the steel and stainless steel components against the salty, highly corrosive water.

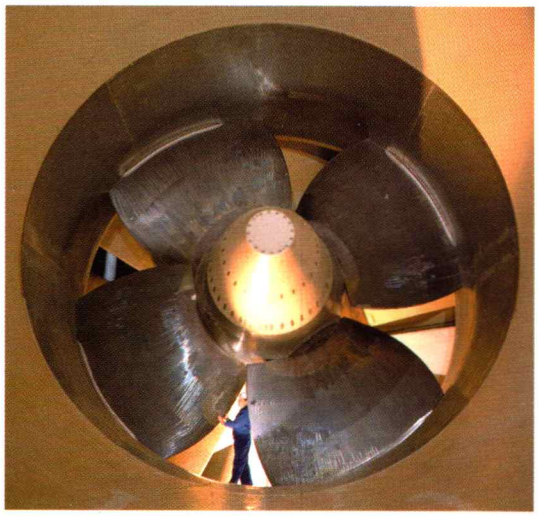


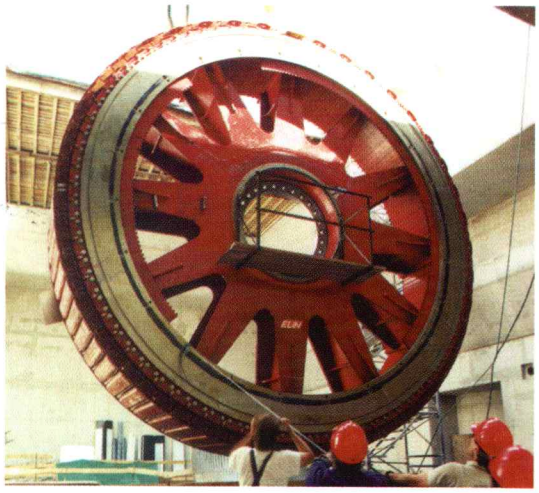
| Technical data: | | |
|---|---|---|
| Output: | 35 | MW |
| Head: | 12.6 | m |
| Speed: | 72 | rpm |
| Runner diameter: | 7,000 | mm |

# BULB TURBINE & GENERATOR EXPERIENCE

## Freudenau Austria

**In 1991 a referendum on the construction of the Freudenau hydropower plant was held in Vienna, which was supported by a majority of approximately 75 %. Just like all existing power plants on the river Danube, Freudenau, which is located within the municipality of Vienna, is a multi-purpose plant.**





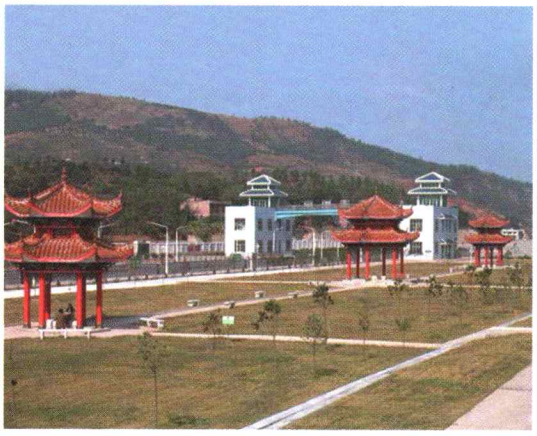
In addition to improving navigation canals and groundwater levels, Freudenau also offers advantages in terms of urban planning and ecology. With an installed output of 172 MW and an annual electricity generation of 1,037 GWh, the Freudenau hydroelectric power plant supplies clean energy to the Austrian grid and to the city of Vienna.

VA TECH HYDRO was involved in the supply of main turbine components for six large Bulb turbines, four radial spillway gates with flap with a width of 24 m, five sets of portal stoplogs, one set of floating stoplogs and intake trashracks, six Bulb generators as well as two four-winding 96 MVA main transformers, 0.4 kV switchgear, excitation, protection and control systems. Easy maintenance is a major aspect in particular with the Bulb turbines and generators on account of their compact design. This fact was already taken into consideration by VA TECH HYDRO at the design stage. The plant was completed in 1997/98.

| Technical data: | | |
|---|---|---|
| Output: | 30.3 MW / 32 | MVA |
| Voltage: | 10.5 | kV |
| Head: | 10.8 | m |
| Speed: | 65.2 | rpm |
| Runner diameter: | 7,500 | mm |
| Stator diameter: | 8,750 | mm |

# Da Yuan Du China

**The Da Yuan Du hydropower station, located on the Jiuliandeng, main stream of the Xiangjiang River, Hunan Province, China, is part of the second-stage of the Xiangjiang Navigation Multi-purpose Project.**



In 1996 VA TECH HYDRO was awarded a contract to supply four Bulbturbine / Generator units with a total installed capacity of 120 MW and annual energy of 556.5 GWh. The scope of supply included engineering, manufacturing and installation supervision as well as commissioning of the electro-mechanical equipment:

- Four Bulb turbines including electronic-hydraulic speed governors of the digital type
- Four three-phase Bulb generators including excitation system
- 10.5 kV generator switchgear
- Main transformers
- Unit protection system
- Power plant supervisory control system
- SF6 circuit breakers and 110 kV cables
- Cabling

The project was completed in November 1999.

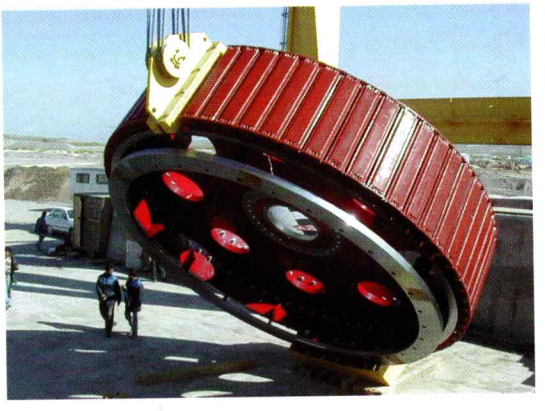
| Technical data: | | |
|---|---|---|
| Output: | 31.3 MW / 33.4 | MVA |
| Voltage: | 10.5 | kV |
| Head: | 11.2 | m |
| Speed: | 65.2 | rpm |
| Runner diameter: | 7,500 | mm |
| Stator diameter: | 9,000 | mm |

# BULB TURBINE & GENERATOR EXPERIENCE

## Karkamis Turkey

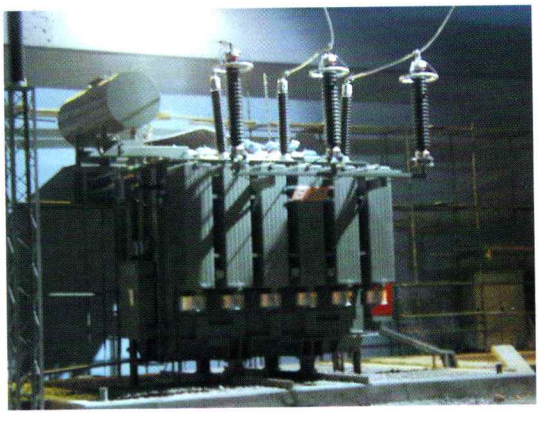
**The power plant is located on the Euphrates River in the south-eastern part of Turkey, approximately 80 km from Gaziantep, the district capital, near the Syrian border.**

In the 1980s, Verbundplan and Temelsu – our engineering partners in the consortium – designed the project for the Government of Turkey. After the project had been shelved for some years, a consortium under the leadership of VA TECH HYDRO proposed to build this project on a turnkey basis in accordance with the guidelines of the bilateral protocol between Turkey and Austria for co-operation in the field of hydropower plants. After successful negotiations, the contract with the General Directorate of State Hydraulic Works (DSI) was signed in 1995 and construction work started in June 1996. The power plant commenced commercial operation in December 1999 after a construction



time of 43 months, more than 1 month ahead of schedule. The project included a powerhouse, a spillway system with gates and two earthfill dams.

The scope of supply of VA TECH HYDRO comprised six Bulb generators, three main transformers, protection, excitation and control systems, generator switchgear, a 154 kV



switchyard, AC station service, DC system with batteries, chargers and inverters, an emergency Diesel generator set, transformer fire fighting equipment, telecommunication equipment, cables and a powerhouse crane.

| Technical data: | | |
|---|---|---|
| Output: | 34.8 | MVA |
| Voltage: | 9.0 | kV |
| Speed: | 88.2 | rpm |
| Stator diameter: | 7,500 | mm |

# Ybbs Persenbeug Austria

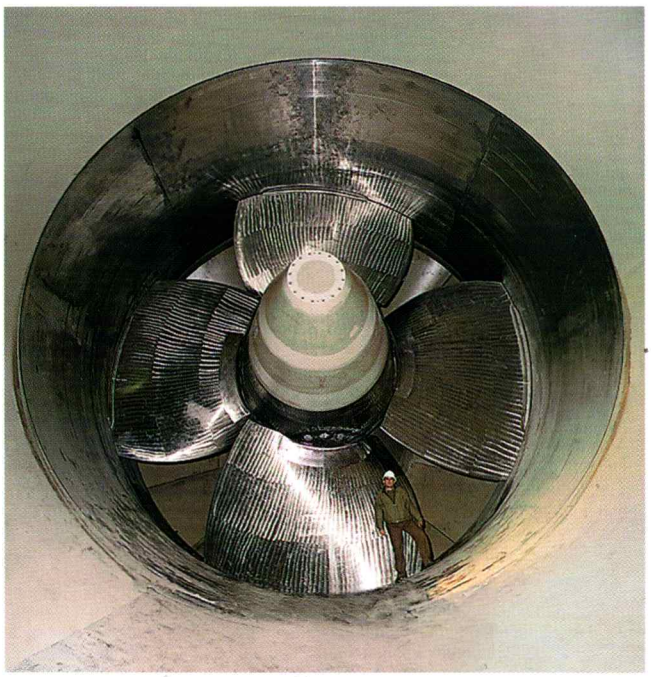
**The power station Ybbs Persenbeug in Lower Austria was built from 1954 to 1959 and was the first hydroelectric station on the river Danube in Austria.**

The two powerhouses (north and south) were equipped with three vertical shaft Kaplan turbines each having a weir system in the middle and a double ship lock next to it.

In the 1990s one additional unit was installed while the power station was fully operable. This unit is the largest Bulb turbine installation in Europe with a maximum output of 55 MW.

It has all the advantages of a state-of-the-art low head installation and increases the annual energy generation in comparison to the other Danube river power stations.

VA TECH HYDRO supplied major parts of the turbine and the generator of this large unit. Today this is considered a classic example of increasing the efficiency of existing power plants.

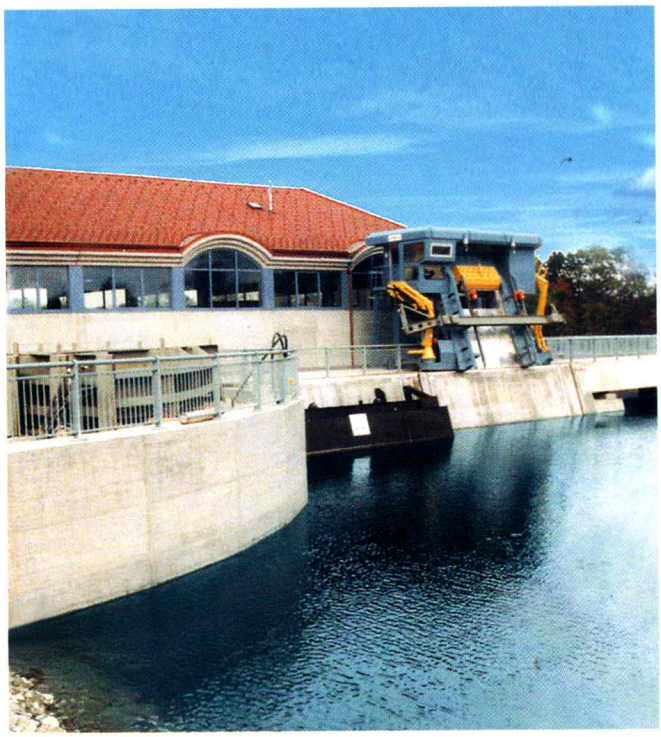


| Technical data: | | |
|---|---|---|
| Output: | 48.5 MW / 55 | MVA |
| Voltage: | 8 | kV |
| Head: | 12.1 | m |
| Speed: | 75 | rpm |
| Runner diameter: | 7,500 | mm |
| Stator diameter: | 8,750 | mm |

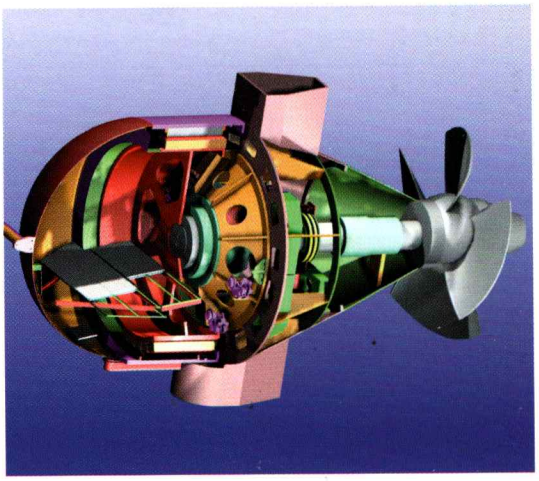
# BULB TURBINE & GENERATOR EXPERIENCE

## Lambach Austria

**This power station is located on the river Traun near Linz in Upper Austria and features the latest development of VA TECH HYDRO's low head equipment including two Bulbturbine / Generator units of the BULB 2000 design.**



The BULB 2000 is a very efficient solution for low head power stations developed for medium-size power plants with further simplification and reduction of auxiliary equipment including generator cooling system.
For this reason the overall efficiency of the units is very high and the investment cost could be reduced drastically thus offering a very feasible solution for run-off river power stations.



VA TECH HYDRO supplied the entire electromechanical equipment including hydraulic steel structures for this plant.

| Technical data: | | |
|---|---|---|
| Output: | 8 MW / 10 | MVA |
| Voltage: | 6.3 | kV |
| Head: | 8 | m |
| Speed: | 150 | rpm |
| Runner diameter: | 3,600 | mm |
| Stator diameter: | 4,500 | mm |

# Fei Lai Xia
# China

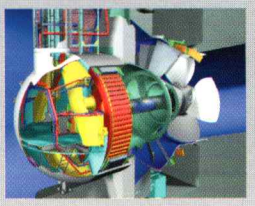
**The Fei Lai Xia Water Conservancy Project is located in Shenpiing Town, Qingxing county, Qingyuan city of Guangdond province, in China, 50 km downstream of Yingde city and 33 km upstream of Qingyuan city. It is the 4th cascade of the cascade development plan for the main stream of the Northern Pearl river basin.**

The main purposes of the project include flood control, keep navigation level and power generation. The structural arrangement of the project comprises the powerhouse, the navigation lock, the spillway and the earth dam from the left to the right bank. The total length of the dam crest is 2,100 m and a maximum height of 50 m. The normal storage level for power generation is 24 m with daily regulation performance. The powerhouse is located in the river channel, equipped with four Bulb type units.

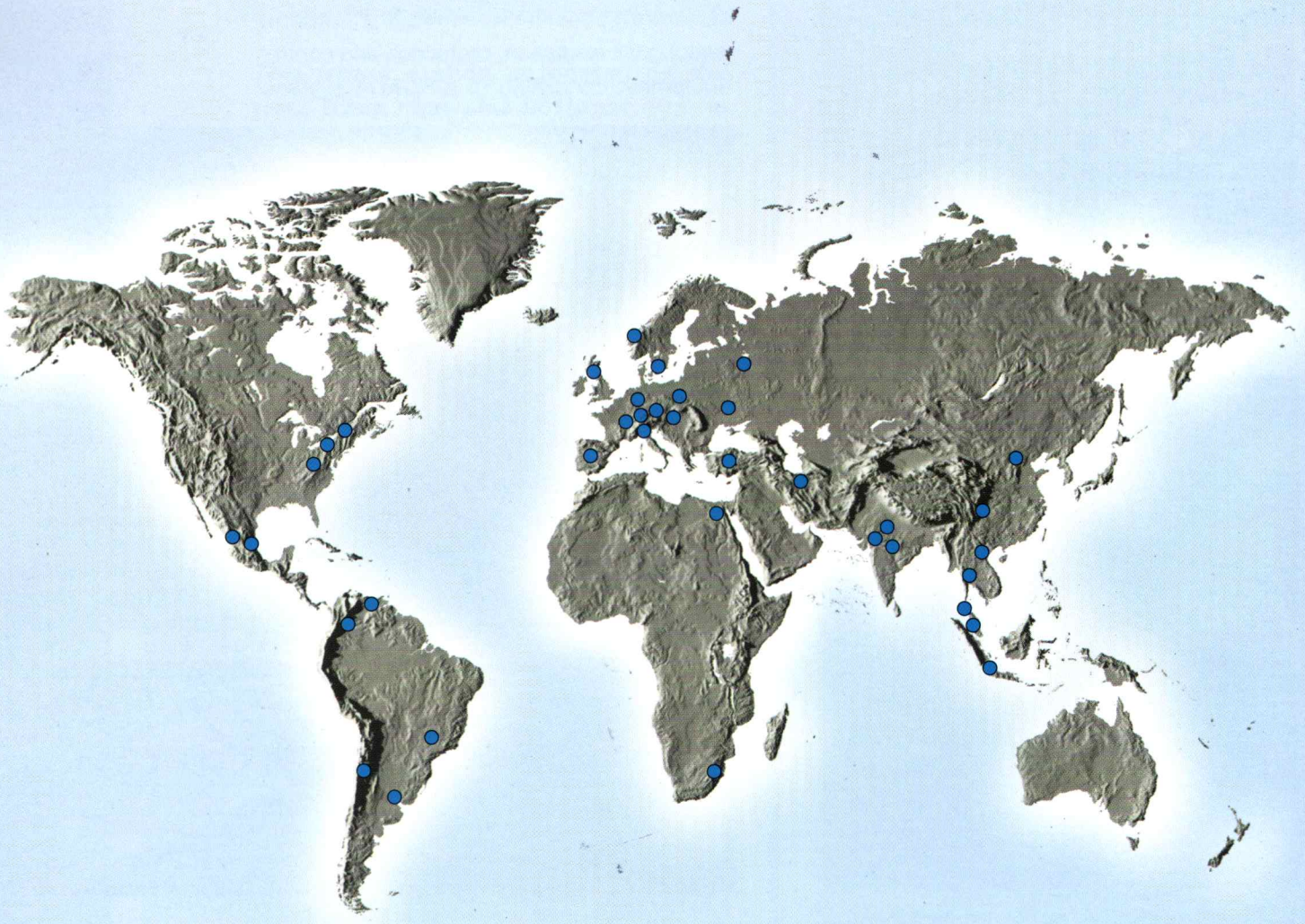
The scope of supply included four Bulb turbines with digital governors, four generators, 17.5 kV medium voltage switchgear, excitation, protection and control equipment consisting of a SCADA system,

joint control with efficiency dependent optimization of unit operation, active mosaic board in the main control room, bi-directional data communication with load dispatch centre through gateway.

| Technical data: | | |
|---|---|---|
| Output: | 39 MW / 43 | MVA |
| Voltage: | 10.5 | kV |
| Head: | 14 | m |
| Speed: | 83.3 | rpm |
| Runner diameter: | 7,000 | mm |
| Stator diameter: | 8,600 | mm |



# VA TECH HYDRO worldwide



**Set-ups in Argentina, Austria, Australia, Brazil, Canada, Chile, China, Colombia, Egypt, France, Germany, Hungary, India, Indonesia, Iran, Italy, Malaysia, Mexico, Norway, Poland, Russia, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, United Kingdom, Ukraine, USA, Venezuela and Vietnam.**

## VA TECH HYDRO


e-mail: contact@vatech-hydro.com

Penzinger Strasse 76
A-1141 Vienna, Austria
Phone: (++43/1) 89 100 - 2963
Fax: (++43/1) 89 100 - 3821

Lunzerstrasse 78
A-4031 Linz, Austria
Phone: (++43/70) 6987 - 3451
Fax: (++43/70) 6980 - 2554

Escher-Wyss-Strasse 25
D-88212 Ravensburg, Germany
Phone: (++49/751) 83 - 2941
Fax: (++49/751) 83 - 3280



©HYD.LH.35.4000.L.D02


sustainable solutions. for a better life.

**www.vatech-hydro.com**

VOEST MCE ELIN SAT AUTOMATION